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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/820,068	03/28/2001	Wei Pan	SLA 0493	4042

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EXAMINER

LUHRS, MICHAEL K

ART UNIT PAPER NUMBER

2824

DATE MAILED: 02/26/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

# Office Action Summary

Application N .

09/820,068

Applicant(s)

PAN ET AL.

Examiner

Michael K. Luhrs

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

## Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

## Status

- 1) ☐ Responsive to communication(s) filed on \_\_\_\_.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

## Disposition of Claims

- 4) ☒ Claim(s) 1-20 is/are pending in the application.
- 4a) Of the above claim(s) 14-20 is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-12 is/are rejected.
- 7) ☒ Claim(s) 13 is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_ are subject to restriction and/or election requirement.

## Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 28 March 2001 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on \_\_\_\_ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

## Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

## Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) \_\_\_\_.
- 4) ☐ Interview Summary (PTO-413) Paper No(s). \_\_\_\_.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☒ Other: *search history*.

## **DETAILED ACTION**

### ***Claim Objections***

1. Claim 13 is objected to under 37 CFR 1.75(c), as being of improper dependent form for failing to further limit the subject matter of a previous claim. Applicant is required to cancel the claim(s), or amend the claim(s) to place the claim(s) in proper dependent form, or rewrite the claim(s) in independent form. Claim 13 does not add a further limit to the method of claim 9 which already indicates an IC device. The product by process indicated in claim 13 is being mixed into the method of claim 9 causes confusion.

### ***Election/Restrictions***

2. Restriction to one of the following inventions is required under 35 U.S.C. 121:
  - I. Claims 1-8 and 9-12, drawn to method, classified in class 438, subclass 586.
  - II. Claims 14-20, drawn to product by process device, classified in class 257, subclass 762.

Inventions I and II are related as process of making and product made. The inventions are distinct if either or both of the following can be shown: (1) that the process as claimed can be used to make other and materially different product or (2) that the product as claimed can be made by another and materially different process (MPEP § 806.05(f)). In the instant case group I, the process as claimed can be used to make other and materially different product, i.e. as pre-treatment for other layers not necessarily for IC device.

Because these inventions are distinct for the reasons given above and have acquired a separate status in the art as shown by their different classification, restriction for examination purposes as indicated is proper.

During a telephone conversation with David C. Ripma on February 19, 2002 a provisional election was made without traverse to prosecute the invention of 09/820068; Attorney Docket No. SLA 0493, claims 1-8 and 9-12. Affirmation of this election must be made by applicant in replying to this Office action. Claims 14-20 are withdrawn from further consideration by the examiner, 37 CFR 1.142(b), as being drawn to a non-elected invention.

Applicant is advised that the reply to this requirement to be complete must include an election of the invention to be examined even though the requirement be traversed (37 CFR 1.143).

Applicant is reminded that upon the cancellation of claims to a non-elected invention, the inventorship must be amended in compliance with 37 CFR 1.48(b) if one or more of the currently named inventors is no longer an inventor of at least one claim remaining in the application. Any amendment of inventorship must be accompanied by a request under 37 CFR 1.48(b) and by the fee required under 37 CFR 1.17(i).

3. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time

a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

***Claim Rejections - 35 USC § 103***

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

4. Claims 1-8 and 9-13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Agarwal (USPN 6,218,256 B1 filed Apr. 13, 1999) in view of Tseng, et. al. (USPN 6,291,343 B1 filed Jan. 20,1998).

Agarwal teaches of new electrode and capacitor structures and methods of fabrication (column 2 lines 9-10) of integrated circuits. Fig. 7 shows a trench or via for an integrated circuit which includes barrier metal layer 16 and electrically conductive layer 18 as described in column 7 lines 9-15, and in column 5 lines 64-66. Specifically copper is listed in line 8 of column 6 for the conductive layer, and also in line 54 of column 9. The pre-treatment is described in column 8 beginning line 61, and in a specific embodiment beginning line 12 of column 9, pre-treatment can be a separate step, 44, referring to Fig. 9 (flowchart). Agarwal provides the temperature range of 300-500°C in line 18 of column 9, i.e. a range that is greater than the 200 degrees as claimed in claim 1 the present invention.

The only processing parameter listed by the claim absent from Agarwal is the thirty second time period. Tseng, et. al. teaches of the time period for a plasma anneal, (line 27-29 of column 6) as a 'preferred plasma annealing time being in the range of 20-40 seconds', (see lines 49-51 of

column 6). The times taught by Tseng, et. al. inherently apply to Argawal when the processing conditions provided by Tseng, et. al. are comparable to those provided by Argawal.

Regarding claim 2, Agarwal's temperature range of 300-500°C is narrower and within the range, as compared to the 250 to 550 degrees Celsius of claim 2. There is no need to resort to Tseng, et. al. for a temperature range, however since the thirty second time period was provided by Tseng et. al. for the independent claim above, it is prudent to check whether the other processing conditions are similar. It is found that Tseng, et. al. also has a similar temperature range of 300 to 475 °C (line 48 of column 6) and it is further recognized that the plasma anneal method provided by Tseng et. al. is essentially analogous to that provided by Agarwal.

Regarding claim 3, Agarwal teaches of exposing the barrier layer to an oxidizing gas at vacuum and further provides the choice of adding argon gas, see lines 17-25 of column 9.

Regarding claim 4, Agarwal provides a pressure range of about 0.01-1 atm as compared to the range of 0.1mTorr to 200 Torr of claim 4.

Regarding claim 5, Agarwal teaches of exposing the barrier metal layer to a temperature of greater than 200 degrees Celsius, but Agarwal fails to teach the time duration. Tseng, et. al. teaches of the time period for a plasma anneal of 15 to 300 seconds (lines 49 of column 6) and in lines 49-51 of column 6 as a 'preferred plasma annealing time being in the range of 20-40 seconds'. The times taught by Tseng, et. al. inherently apply to Agarwal when the processing conditions provided by Tseng, et. al. are comparable to those provided by Agarwal.

Regarding claim 6, Agarwal teaches of the trench having side wall bottom surface, wherein a copper is deposited in the trench, against side wall and bottom surface (see Fig. 7), however fails to teach the exact trench width or of the deposition "throughout". Nevertheless, Agarwal

explicitly teaches the electrode (line 1 of abstract), whereas implicit to Fig. 7 as an electrode, it would then be filled 'throughout'. For thickness, one can sum together the various thicknesses of the layers within the trench to reach a final value of 1300Å, and therefore Agarwal implicitly teaches trench thickness, (i.e. copper layer 18 is approx. 50-500Å, barrier layer is approx. 5-50Å, and dielectric layer 14 is approx. 30-100Å, *times two*, for each side, which would total to a trench width of 1300Å which equals 0.13 μm, the trench width value in the claim. The barrier layer can be even thinner, which would make the final trench thickness less than 0.13 μm). These values are found at line 51 of column 9, line 34 of column 5, and line 58 of column 4, respectively. The motivation is obvious, i.e. for smaller devices, and, for an electrode, filling of the trench (with the copper in this case) would be an inherent necessity.

Regarding claims 7 and 12, Agarwal does not teach of adhesion properties, but it is inclusive to the selection of the barrier layer, as titanium nitride, is the known adhesive benefit it provides. In addition, the Tseng, et. al. reference is entitled "Plasma Annealing of substrates to improve adhesion", for which it is known, therefore, of plasma annealment particularly to improve adhesion. The claim is absent of specific parameters regarding the tape test, but it is reasonable that improvements for the adhesiveness provided by the references are sufficient motivation to believe that the copper could endure a tape test.

Regarding claim 8, Agarwal teaches that the barrier layer can be of titanium nitride and tantalum nitride in line 26 of column 2.

Regarding independent claim 9, Agarwal teaches of pretreatment of barrier metal layer for partially finished integrated circuit device or to complete a device, specifically electrode or capacitor, which includes barrier metal layer 16 shown by Fig. 4, subjecting barrier metal layer

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to a temperature greater than 200 degrees in vacuum, as explained in lines 13-24 of column 9, (where additionally Argon can be included), and thereafter depositing copper as in line 54 of column 9. Agarwal fails to teach the time period: the thirty second duration expressed in claim 9. A thirty second plasma annealing time is taught by Tseng, et. al., see line 51 of column 6; “preferred plasma annealing time being in the range of 20-40 seconds”.

Regarding claim 10, Agarwal teaches of subjecting the barrier metal layer in a vacuum, in column 9 lines 13-21. A range of 0.01-1 atm is provided, is a vacuum. (Note that claim 9 permits the choice of “ambient vacuum, Hydrogen gas, Argon gas, and Helium gas” and should one choose the ‘ambient vacuum’ from claim 9, then the *simultaneous* pressure range provided by claim 10 is confusing, i.e. you cannot have simultaneous pressure.)

Regarding claim 11, Agrawal teaches of the trench width implicitly, as explained earlier, please refer to claim 6 rejection above.

Regarding claim 13, Agarwal teaches that the method can be applied to device such as electrode or capacitor. One would be motivated to apply the procedure within the manufacture of a device having the trench structure because of the resistivity and adhesive benefits.

### ***Conclusion***

5. The examiner includes a copy of Chern, et. al. (USPN 6,251, 758 B1) relevant to the subject matter of the present application with this communication.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Michael K. Luhrs whose telephone number is 703-305-2864.

The examiner can normally be reached on M-F; 8:00 a.m. - 5:00 p.m..



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If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Richard T. Elms can be reached on 703-308-2816. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9318 for regular communications and 703-872-9319 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.

*MKL*

Michael K. Luhrs  
February 22, 2002

*Michael S. Lebentritt*  
MICHAEL S. LEBENTRITT  
PRIMARY EXAMINER